(19)F spin-lattice relaxation of perfluoropolyethers: Dependence on temperature and magnetic field strength (7.0-14.1T).

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Authors: Deepak K Kadayakkara, Krishnan Damodaran, T Kevin Hitchens, Jeff W M Bulte, Eric T Ahrens

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Public Summary:
Fluorine ((19)F) MRI of perfluorocarbon-labeled cells has become a powerful technique to track the migration and accumulation of cells in living organisms. It is common to label cells for (19)F MRI with nanoemulsions of perfluoropolyethers that contain a large number of chemically equivalent fluorine atoms. Understanding the mechanisms of (19)F nuclear relaxation, and in particular the spin-lattice relaxation of these molecules, is critical to improving experimental sensitivity. To date, the temperature and magnetic field strength dependence of spin-lattice relaxation rate constant (R1) for perfluoropolyethers has not been described in detail. In this study, we evaluated the R1 of linear perfluoropolyether (PFPE) and cyclic perfluoro-15-crown-5 ether (PCE) at three magnetic field strengths (7.0, 9.4, and 14.1T) and at temperatures ranging from 256-323K. Our results show that R1 of perfluoropolyethers is dominated by dipole-dipole interactions and chemical shift anisotropy. R1 increased with magnetic field strength for both PCE and PFPE. In the temperature range studied, PCE was in the fast motion regime (omegatauc<1) at all field strengths, but for PFPE, R1 passed through a maximum, from which the rotational correlation time was estimated. The importance of these measurements for the rational design of new (19)F MRI agents and methods is discussed.

Scientific Abstract:
Fluorine ((19)F) MRI of perfluorocarbon-labeled cells has become a powerful technique to track the migration and accumulation of cells in living organisms. It is common to label cells for (19)F MRI with nanoemulsions of perfluoropolyethers that contain a large number of chemically equivalent fluorine atoms. Understanding the mechanisms of (19)F nuclear relaxation, and in particular the spin-lattice relaxation of these molecules, is critical to improving experimental sensitivity. To date, the temperature and magnetic field strength dependence of spin-lattice relaxation rate constant (R1) for perfluoropolyethers has not been described in detail. In this study, we evaluated the R1 of linear perfluoropolyether (PFPE) and cyclic perfluoro-15-crown-5 ether (PCE) at three magnetic field strengths (7.0, 9.4, and 14.1T) and at temperatures ranging from 256-323K. Our results show that R1 of perfluoropolyethers is dominated by dipole-dipole interactions and chemical shift anisotropy. R1 increased with magnetic field strength for both PCE and PFPE. In the temperature range studied, PCE was in the fast motion regime (omegatauc<1) at all field strengths, but for PFPE, R1 passed through a maximum, from which the rotational correlation time was estimated. The importance of these measurements for the rational design of new (19)F MRI agents and methods is discussed.